B-tagging Performances

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Introduction

b-tagging is an important tool for physics at LHC:

- Aim is to tag inclusively high-pT b-jets
  - Searches:

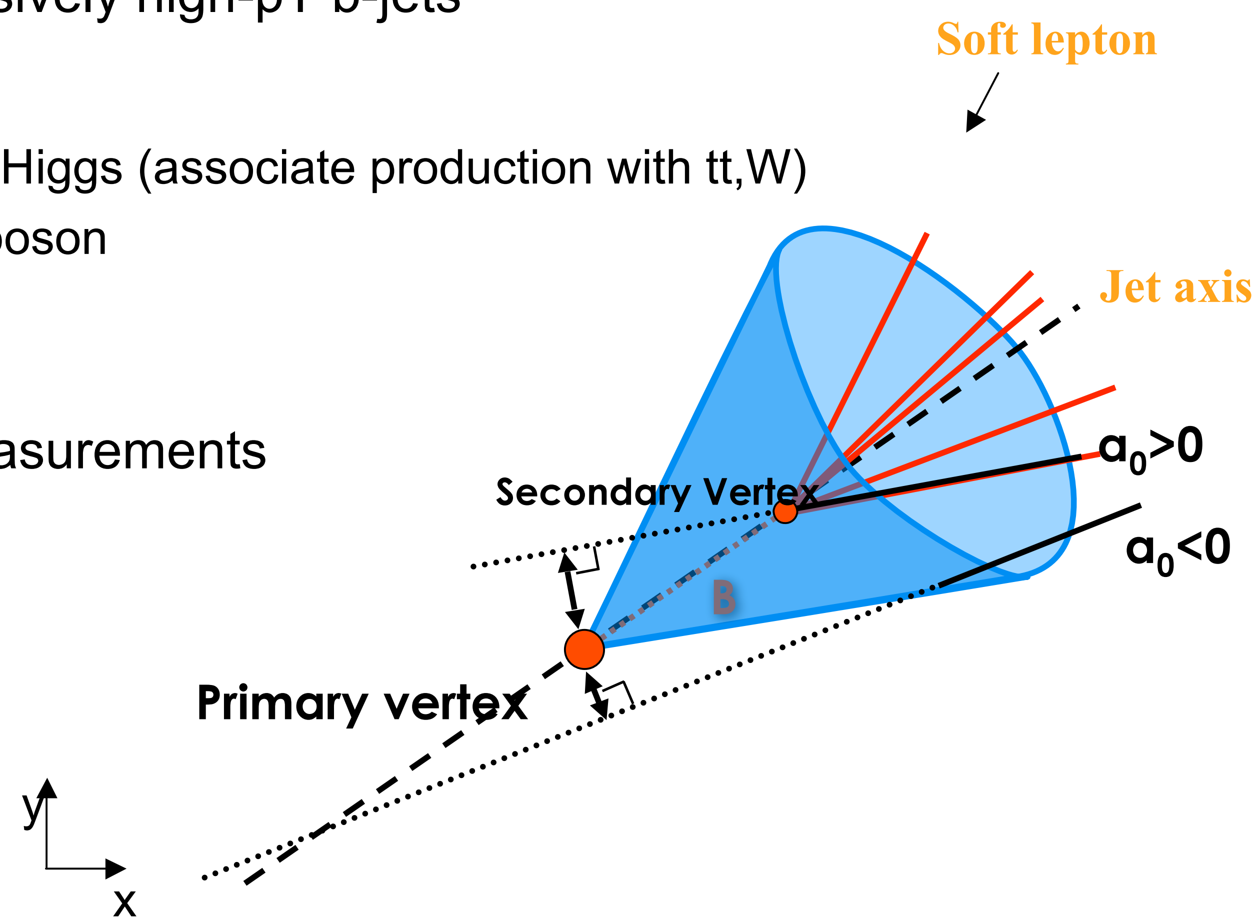
    Low mass SM Higgs (associate production with tt,W)

    MSSM Higgs boson

    SUSY

    …
  - Precision measurements

    Top physics

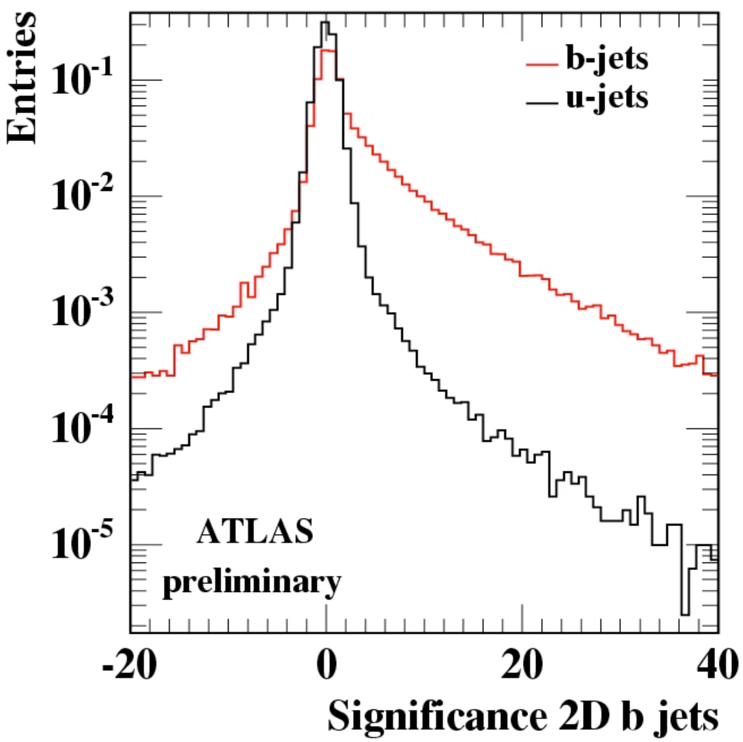


Outline of the talk

- Summary on taggers
- Performance
  - Different physics samples
  - Different releseas
    - Tracking,generators,…
- First Data and b-tagging commissioning
- Conclusions

Building a tagger

- All taggers rely on a comparison between two hypotheses:
  - likelihood for the jet to come from a b-quark vs light quark
- Example: transverse impact parameter



• use the normalized impact parameter significance (S = d_0/σ_d) of each track
• compare it to predefined calibration p.d.f. for the b and light hypothesis
➔ b(S) and u(S)
• sum over all tracks ➔ jet btag weight

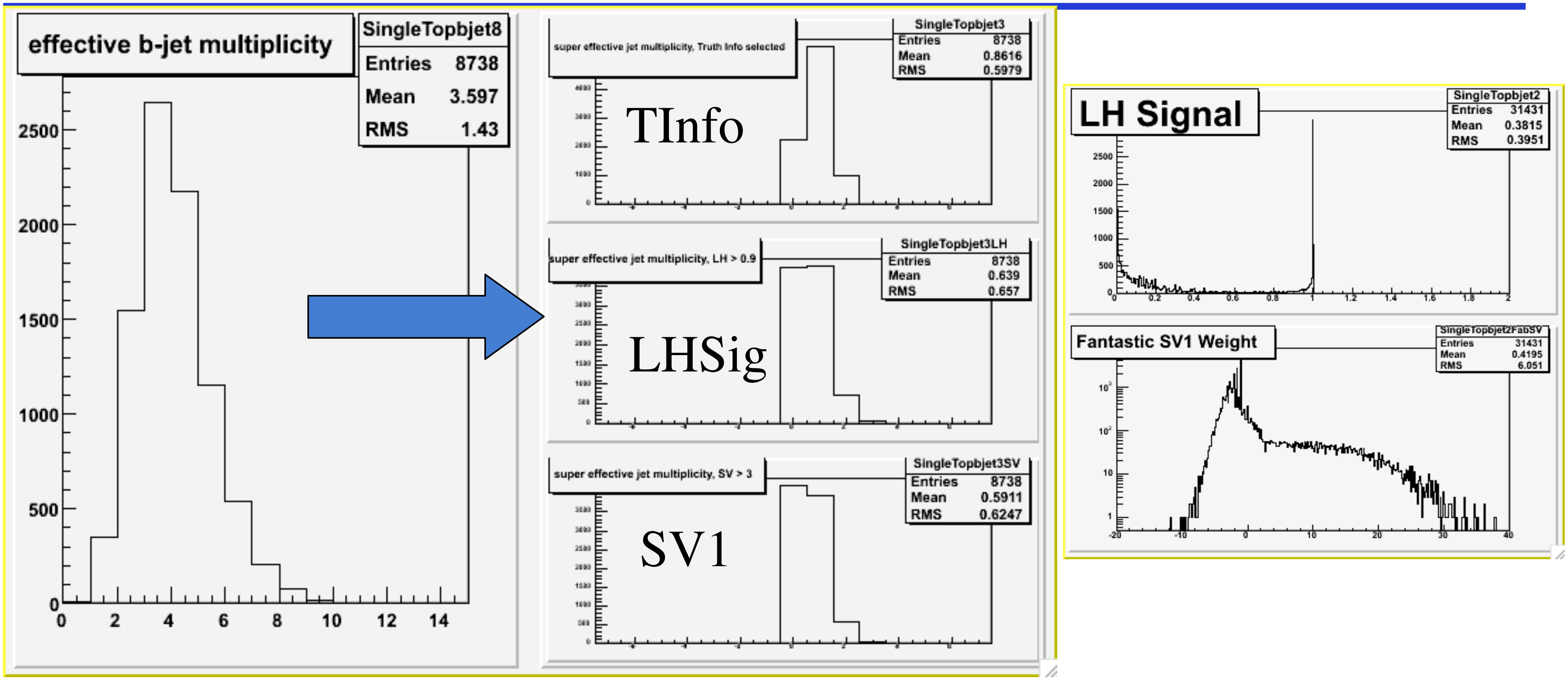
$$W_{jet} = \sum_{tracks} \ln\left(\frac{b(S)}{u(S)}\right)$$

• high W ➔ likely a b-jet

Taggers available

	1st stream (AOD and CBNT)	2nd stream (AOD only)	
IP (long. impact)		Lifetime1D	needs good primary reconstruction
(trans. impact)	IP2D	Lifetime2D	the most robust
	IP3D	Lifetime3D	combination
Inclusive Secondary Vertex	SV1	SecVtxBU	more demanding for tracking
	SV2	SecVtxTD	
Pre-defined combination	"weight": IP3D + SV1	"lhSig"	

b-jet selection (Wt events)



From the BJet collection jets are selected using TruthInfo, LHSig and SV1

Performances

B-tagging performance estimators

- B-jet efficiency ε_b as function of variable cut:
  - Denominator:
    - jets defined as b using MC truth
      - with fixed p_T and η cuts (p_T> 50 GeV/c, $|\eta|$<2.5)
  - Numerator:
    - ditto + cut on a tagging weight
- Light-jet rejection $R_u = 1 / \varepsilon_u$
  - R=100 means 1% mistag rate
  - light jets: u, d, s, g
- B-jet efficiency as a function of P_T and η
  - Denominator:
    - jets defined as b using MC truth
      - with fixed cut on weight (SV1 > 3, LHSig > 0.9)
  - Numerator:
    - ditto + cut on p_T and η

Performance Studies

Many of the performance studies are motivated by physics studies
It is important to study b-tagging for different samples and in the context of each physics analysis

- The b-tagging performances depend (at least) on the jet p_T, η and isolation (event topology)
- The optimization of b-tagging algorithms and the use of b-tagged jets in analysis cuts also depend on the specific physics analysis
- The understanding of b-tagging performances can be a significant systematics for the analyses which make use of this tool

- **SUSY**
  - Tommaso Lari (Milano)
- **Higgs**
  - WH validation -Marseille
  - WH validation (Siegen University)
  - Little Higgs (high PT b-jets) (Valencia)
- **Top**:
  - Anne-Isabelle Etienvre (Saclay)
  - Simona Rolli (Tufts)
  - Marisa Sandhoff (*Wuppertal*)
  - Marseille group

Various software releases used
- Release Validation
- Tracking Validation
- Generators Validation (fragmentation,decays, etc)
- Jet Algorithms Dependence

B-tag in SUSY Searches

- The most general signature of R-parity conserving Supersimmetry is **hard jets and missing energy**.
- Main backgrounds are **tt, W+jets, Z+jets, QCD multi-jets**
- b jets arises from gluino decays involving b and t squarks. They carry useful information on **third generation of scalar quarks** (enhanced if lighter than first two generations)
- b-tagging can be used to **reject SM backgrounds** (other than tt, bb+jets) and **discriminate between SUSY models/points** in parameter space.

- An analysis was made on Rome Full Simulation samples (tt, W+jets, SU1, SU2, SU3) to investigate the use of b-tagging in SUSY jet+missing Et inclusive searches:
  - W+jets background can be strongly suppressed by b-tagging (FabSV > 4 and P_T > 100 GeV) .
  - Ongoing work on studying bbqq and Z+jets backgrounds.

	0 b-jets	1 b-jet	2 b-jets
tt	24	36	9
W+jets	307	48.6	0
SU1	122	57.1	15.3
S/√B	6.7	6.2	5.1
SU3	253	105	22
S/√B	13.9	11.4	7.4

Tommaso Lari, May 2006

Performance in SUSY/Top events

B-tagging as a tool to discriminate SUSY signal from background

- Analysis based on AOD produced with release 11.0.41 (official pre-CSC production) plus some older Rome samples (not yet available in CSC)
  - B-tagging using lhSig (CERN tagger) or weight (Marseille tagger)
  - Jets are cone 0.4, tracking with iPatRec
- Samples
  - **T1** (tt, MC@NLO, inclusive dileptonic+semileptonic)
  - **SU1, SU2, SU3**, **SU4** (Different SUSY points, JIMMY)
  - **A7** (W+jets, ALPGEN)
- Jet Flavor Identification
  - **b-jet**: b-quark within DR=0.3 cone
  - **c-jet**: c-quark within DR=0.3, no b-quark within DR=0.6
  - **τ-jet**: not identified by τ -tagging, t within DR=0.3
  - **Light jet:** no b,c, τ within DR=0.6

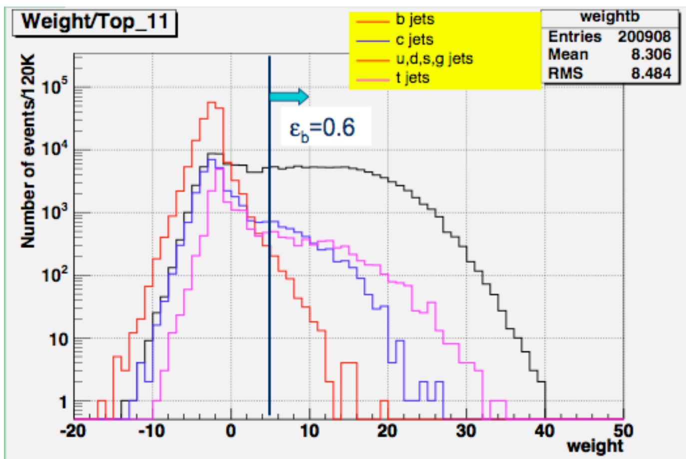
Tommaso Lari, May 2006

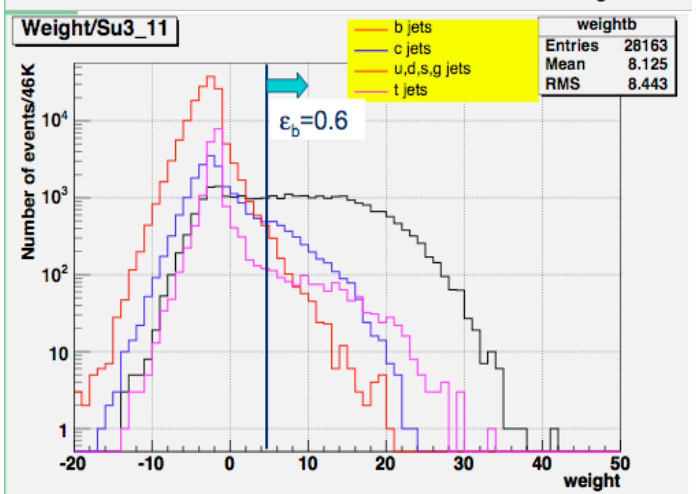
Some jets do not belong to any of above categories and are ignored

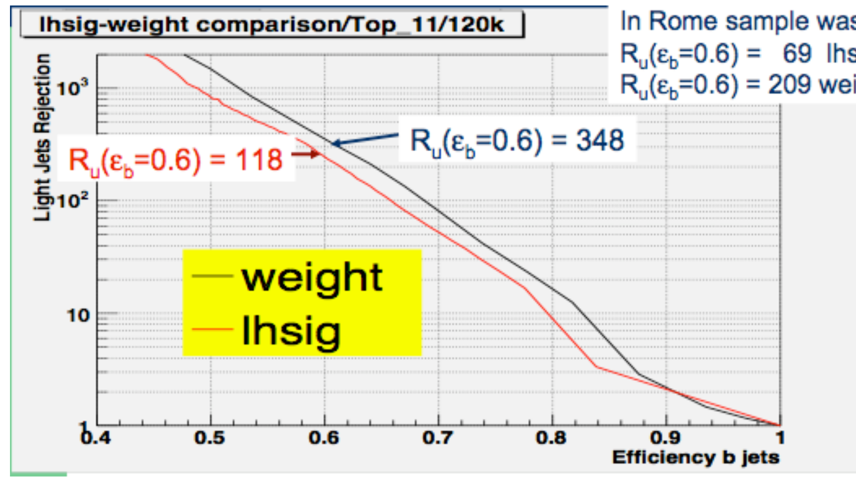
No isolation condition is used to select jets

Dependence on flavour tagging cone size weak. Basically same results if a ΔR=0.8 veto cone is used

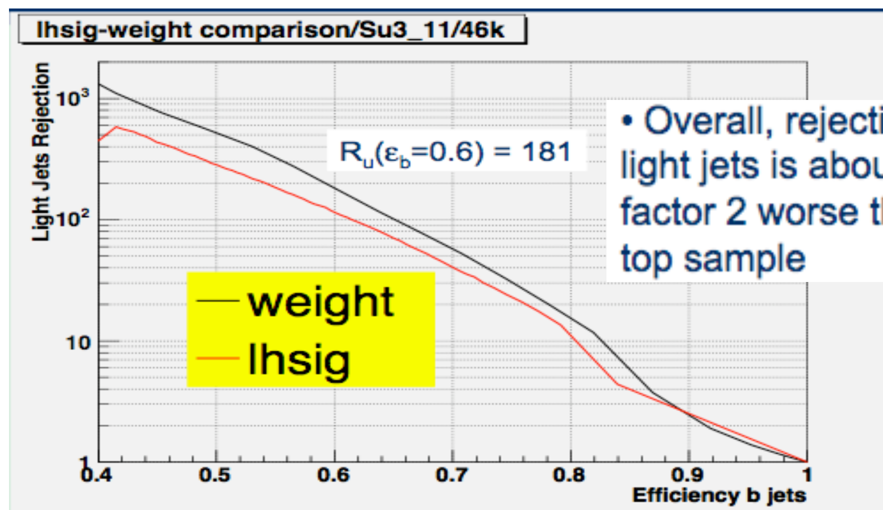
Performance in SUSY/Top events







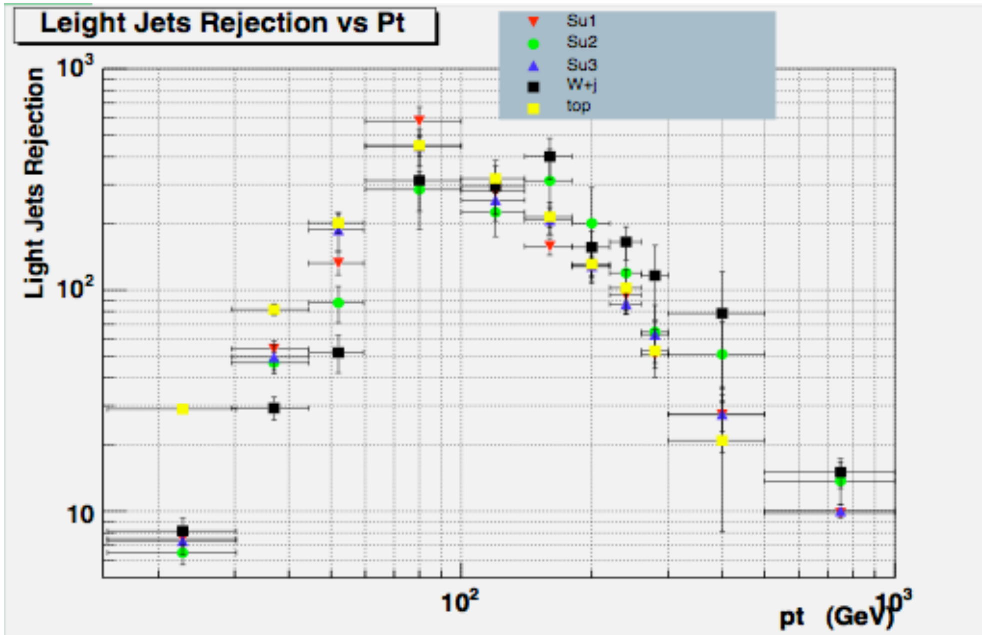
In Rome sample was:
$R_u(\varepsilon_b=0.6)$ = 69 lhsig
$R_u(\varepsilon_b=0.6)$ = 209 weight



- Overall, rejection of light jets is about a factor 2 worse than in top sample

Tommaso Lari, May 2006

Performance in SUSY/Top events



- **b-tagging** (rejection of light jets) **in SUSY samples similar than in top events**, when rejection is plotted **as a function of jet pt**.
  - Exception: jets with very low pt (< 30 GeV) poorly tagged in SUSY events. Need to be further studied
- It is important to **improve b-tagging for very high-pt jets**, which are present in many SUSY (and SUSY-like) events (see Valencia group studies).

Tommaso Lari, May 2006

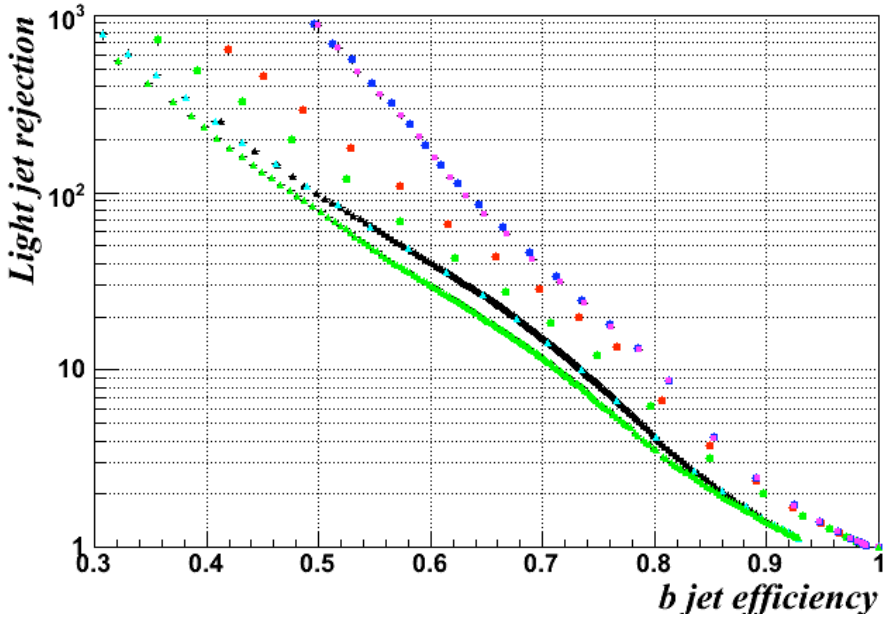
WH(120 GeV) benchmark 10.5.0

J.B.DeVivie

WH events, m_H = 120 GeV/c^2 ,
(Rome layout, datasets 4860/4861)

b-jets: H→ bb
light jets: H→ uu

Release 10.5.0 + patches
xKalman tracks, Cone 0.4 jets



Rejection of light quark jets:

	IP2D	IP3D	SV1+IP3D	SV2+IP3D	lhSig (à la 10.5.0)
50% b-tag effi.	130	208	672	708	100
60% b-tag effi.	50	72	155	153	41

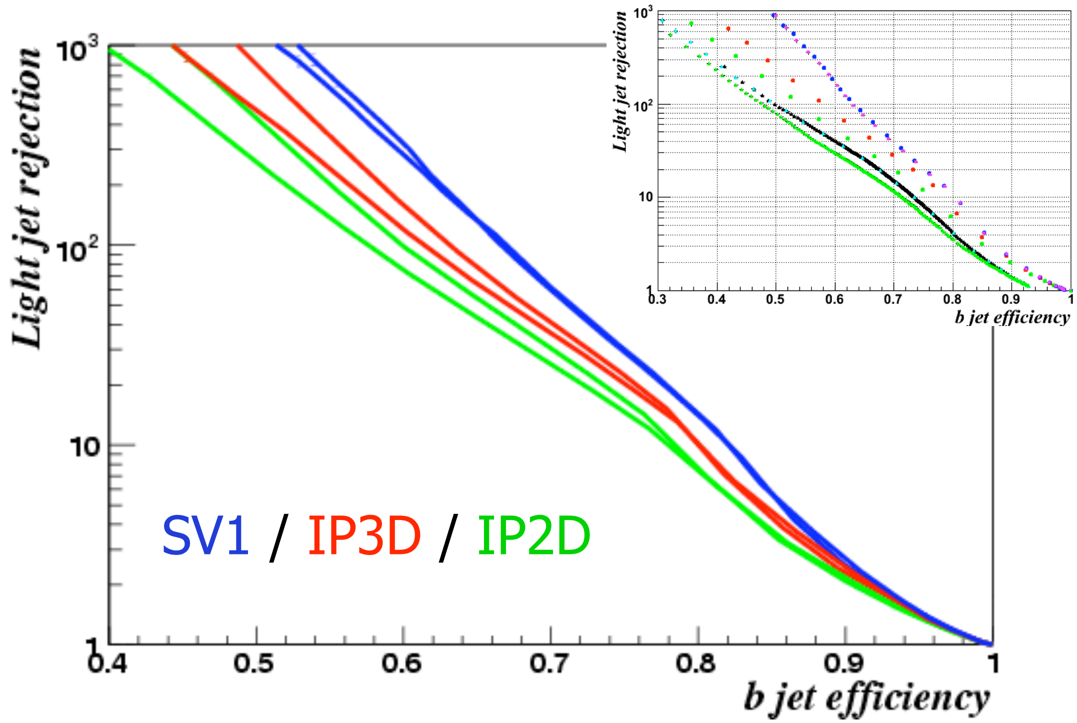
WH(120 GeV) benchmark with 11.0.4x

WH events, m_H = 120 GeV/c^2 ,

Data sample 4860/1 :
Rome with 11.0.3 (private reco)
mc11 with 11.0.41 (official AOD)

Release 11.0.3/4x ,
iPatRec tracks, Cone 0.4 jets

Major change in the ATLAS layout between Rome and CSC : three pixel layer geometry



raw	IP2D	SV1
Rome	76 (270)	285 (1265)
mc11	99 (450)	324 (1550)

Clear improvement with the 3 layers,
e.g. light jet rejection @ ε_b = 60 (50) %

J.B.DeVivie, May 2006

WH(120 GeV) benchmark with 11.0.4x: calibration functions

J.B.DeVivie, May 2006

Use different csc samples to build the calibration functions
Samples 5200 (T1), 5340/1 (ttH), 5850/1/4/7 (WH120, 400)

$\Rightarrow$ Each jet/track enters the pdf with a weight 1

Predefined p.d.f. for b and light quark hypothesis

light jet rejection @ ε_b = 60 (50) %

	IP2D	IP3D	SV1+IP3D	SV2+IP3D
official AODs	75 (281)	109 (476)	192 (1024)	187 (1056)
with recalibration	74 (292)	111 (498)	232 (1222)	234 (1305)

Very small effect for IP (< 5%), Largest effect in SV (~ 20%) as expected (due in particular to the mean SVX finding efficiencies entering the weights :

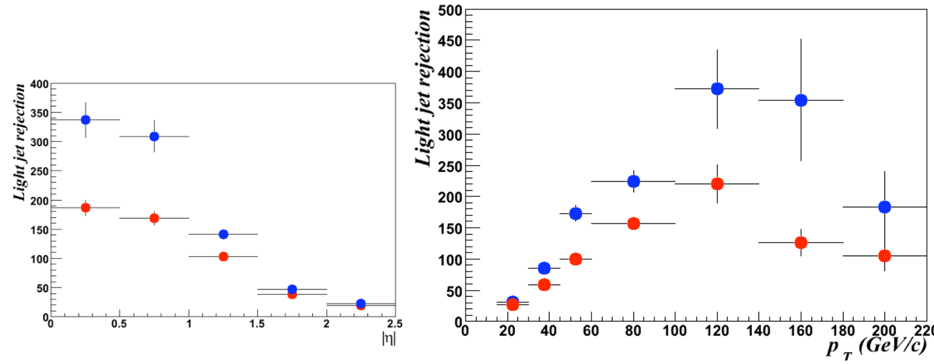
(%)	light jets	b-jets
Rome	2.8	65.2
csc11	4.2	69.2

WH(120 GeV) benchmark with 11.0.4x: Parton Shower

J.B.DeVivie, May 2006

Data sample
-4860/1 : mc11 → old shower (PYEVNT)
-5850/1 : csc11 → new shower (PYEVNW)

Light jet rejection as a function of $|\eta|$ and p_T @ $\varepsilon_b = 60$ % , for IP2D



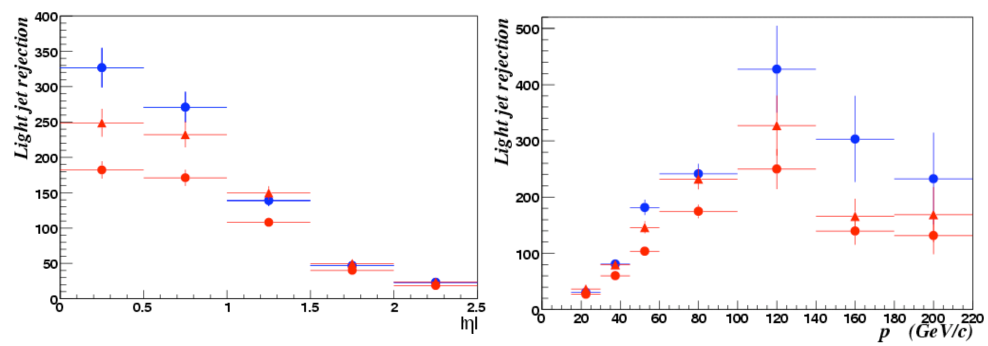
very large degradation, back to Rome performances (or worse) with a 3 pixel layer layout…

very annoying effect since we do not really know which shower model is closest to reality… (PYEVNW should be better but is it properly tuned ?)

Mislabelling of b-quark in PS
Corrected in 12.0.x

IP2D and SV1 @ $\varepsilon_b = 60$ (50) %

raw	IP2D	SV1
mc11	99 (450)	324 (1550)
csc11	75 (281)	192 (1024)



WH benchmark with 11.5.0: Tracking Algs

WH events generated with 11.0.41 (CSC sample A)
Reconstruction 11.5.0
DC3-02 layout

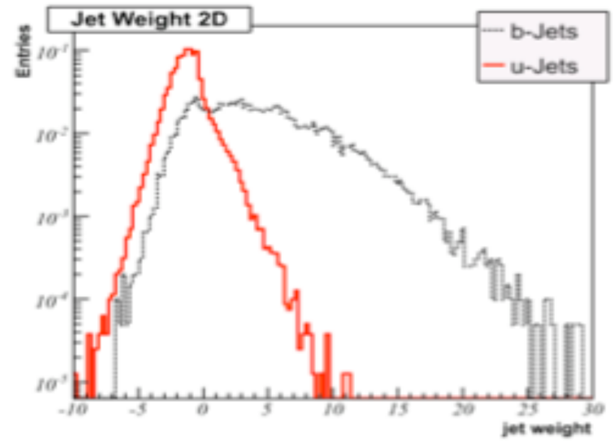
Two taggers considered for performance studies:
- Marseille
- CERN

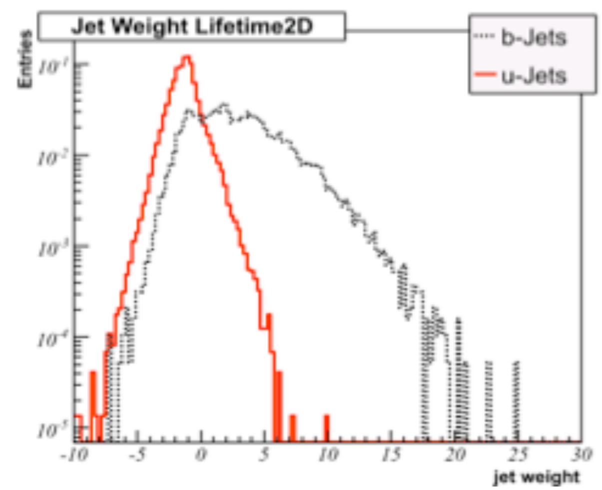
Two tracking algorithms used:
- xKalman
- newTracking

V. Sipica, Siegen May 2006

Particle jets with cone 0.4

Jet weights computed with 11.5.0





WH benchmark with 11.5.0: Tracking Algs

V. Sipica, May 2006

- Performances of Marseille taggers in different steps:
  - 'just taggers' => useSharedHits & rejectBadTracks set to false
  - 'V0 rejection' => rejectBadTracks set to true
- Standard cuts are used to calculate the rejection

xKalman

11.5.0	IP2D		IP3D		IP3D + SV1	
Efficiency	50%	60%	50%	60%	50%	60%
just taggers	175 +/- 8	62 +/- 2	301 +/- 18	98 +/- 3	690 +/- 64	172 +/- 8
+V0 rejection	277 +/- 16	77 +/- 2	432 +/- 32	115 +/- 4	816 +/- 82	192 +/- 9

- Standard cuts are used to calculate the rejection

newTracking

11.5.0	IP2D		IP3D		IP3D + SV1	
Efficiency	50%	60%	50%	60%	50%	60%
just taggers	230 +/- 12	80 +/- 2	528 +/- 42	137 +/- 6	937 +/- 100	255 +/- 14
+V0 rejection	393 +/- 27	107 +/- 4	654 +/- 58	161 +/- 7	1055 +/- 119	267 +/- 15

- newTracking / xKalman:

11.5.0	IP2D		IP3D		IP3D + SV1	
Efficiency	50%	60%	50%	60%	50%	60%
just taggers	1.32 +/- 0.07	1.28 +/- 0.04	1.76 +/- 0.10	1.39 +/- 0.06	1.36 +/- 0.14	1.48 +/- 0.07
+V0 rejection	1.42 +/- 0.09	1.39 +/- 0.05	1.51 +/- 0.12	1.4 +/- 0.06	1.29 +/- 0.15	1.39 +/- 0.07

Similar improvement for CERN taggers

b-tagging in ttbar events: 10.0.1

- ttbar MC@NLO+Jimmy (sample 4100 T1)
- From AODs, cone ΔR=0.4, iPatrec tracks
- b and light jets from same sample: purification
- Statistics: 395k b-jets, 618k(517k) u-jets

Release 10.0.1 + patches

L. Vacavant, Mar 2006

	R_u (ϵ_b=50%) (raw)	R_u (ϵ_b=60%) (raw)	R_u (ϵ_b=50%) (purified)	R_u (ϵ_b=60%) (purified)
IP2D	**158 ± 3**	**55 ± 1**	**181 ± 3**	**60 ± 1**
IP3D	228 ± 4	86 ± 1	258 ± 6	94 ± 1
SV1+IP3D	**505 ± 14**	**184 ± 3**	**773 ± 30**	**240 ± 5**
Lifetime2D	145 ± 2	53 ± 1	169 ± 3	57 ± 1
lhSig	172 ± 3	66 ± 1	200 ± 4	73 ± 1

More in A.I.Etienvre studies in the Top Group (Effects of environment)

b-tagging in ttbar: 11.5.0 vs 12.0.0

Reco	12.0.0	11.5.0	F(12/11)
2D 60%	84 ± 2	75± 4	1.12 ± .06
3D 60%	133 ± 4	130 ± 10	1.02 ± .08
3DSV1 60%	296 ± 12	319 ± 37	0.93 ± .11

CSC tt sample 5200, Simulation 11.0.4, Reconstruction11.5.0/12.0.0, VxPrimary, no shared hits,

b-jet efficiency 60%, iPatrec, old Rome calibration

CSC tt sample 5200,

Simulation 11.0.4, Reconstruction 11.5.0/12.0.0, VxPrimary, no shared hits,

b-jet eff 60%, newTracking, old Rome iPat calibration

Reco	12.0.0	11.5.0	F(12/11)
2D 60%	81 ± 5	92± 6	0.88 ± .07
3D 60%	108 ± 8	154 ± 13	0.70 ± .08
3DSV1 60%	171± 15	265 ± 28	0.65 ± .08

Software issues to be checked: clustering, calibration DB, multiple collections treatment etc

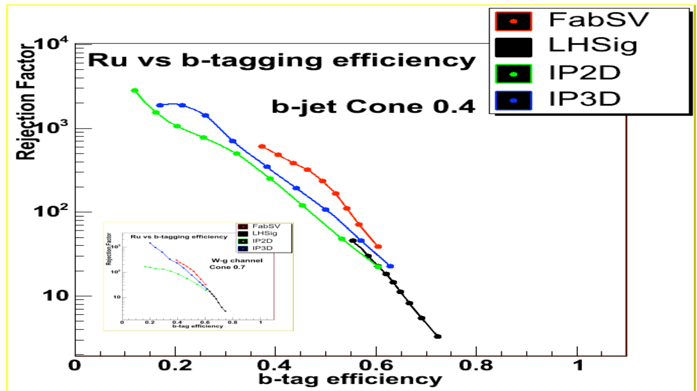
A. Rozanov, , June 2006

b-tagging in Single Top: 10.0.1

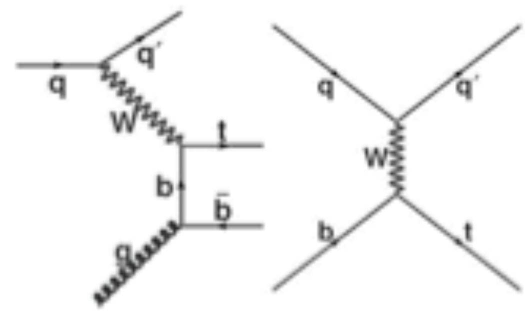
Decay modes:

- W* : W* → t bbar → (l⁺νb) bbar
- Wg: q'g → t q bbar → (l⁺νb) q bba
- W+t: bg → t W → (l⁺νb) qq'

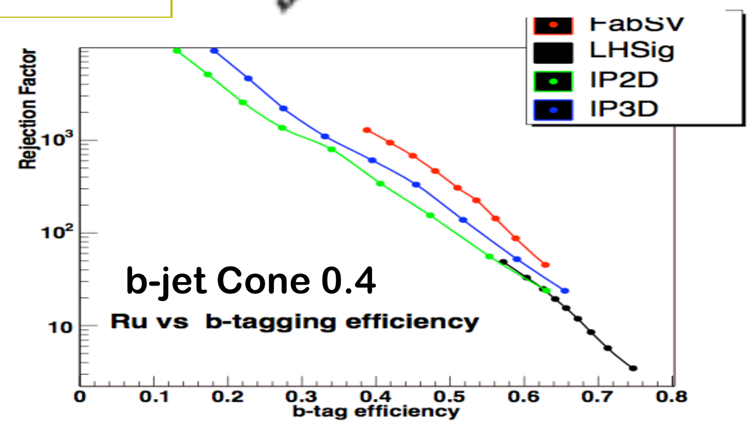
1 leptons + MET
+ ≥ 2 jets
+ 1(2) b-tags

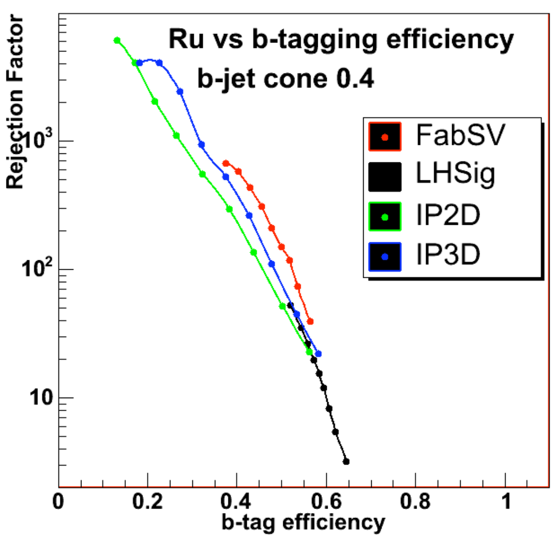


W-g (t-channel)

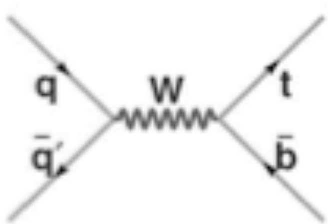


Release 10.0.1 + patches

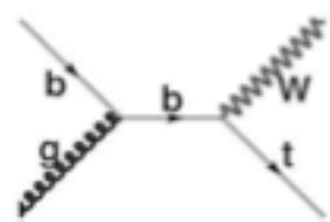




W* (s-channel)



W+t



S. Rolli, June 2006

Wt: b-tagging efficiencies

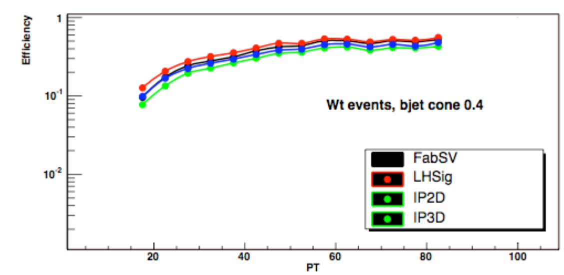
In respect to tagger cut
Denominator: number of jets matched with the b-parton (Tinfo), with $P_T > 50$ GeV, $\eta < 2.5$
Numerator: ditto with cut on weight/likelihood

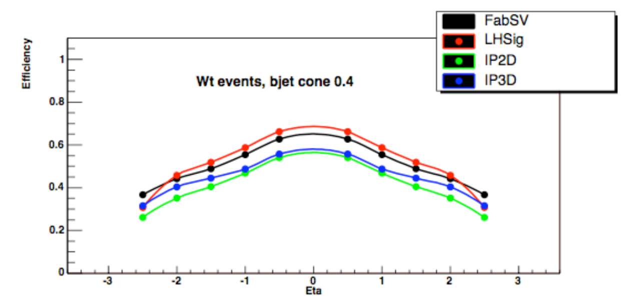
IP2D Cut	Eff Ip2D	SV1 Cut	Eff SV1	LHSig cut	Eff LHsig
1	0.60 0.63	1	0.63 0.63	0.1	0.80 0.75
2	0.54 0.55	2	0.59 0.59	0.2	0.76 0.72
3	0.49 0.48	3	0.55 0.57	0.3	0.72 0.69
4	0.43 0.41	4	0.53 0.54	0.4	0.70 0.67
5	0.38 0.35	5	0.51 0.51	0.5	0.68 0.66
6	0.33 0.28	6	0.48 0.48	0.6	0.67 0.65
7	0.29 0.21	7	0.46 0.46	0.7	0.65 0.63
8	0.25 0.18	8	0.43 0.43	0.8	0.63 0.61
9	0.21 0.14	9	0.41 0.40	0.9	0.60 0.57

Cone 0.7
Cone 0.4

ATL-PHYS-COM-036

In respect to PT and η
Denominator: number of b-partons with P_T and η in given interval;
Numerator: bjets matched with the b-parton (parton level info) with P_T and η in given interval and cut on weight/LHSig.





Remarks on Current Taggers

- All taggers are kept for performance studies and cross-checks

  ⇒ low performance taggers (Lifetime2D/IP2D) are usually rather robust (easier to understand and commission)

  ⇒ high performance ones (SV1/SV2) will require more time to control

  ⇒ taggers identical wrt discriminating variables (Lifetime2D ~ IP2D, Lifetime3D ~ IP3D) are kept for cross-checks and do differ in some point (refined track selection in IPxD, one 2D vs one 1D pdf for IP3D vs Lifetime3D, …)

- For physics analysis, a combination is given :

  - "1st stream" taggers : (*JetTag)→weight()
    corresponding to SV1+IP3D

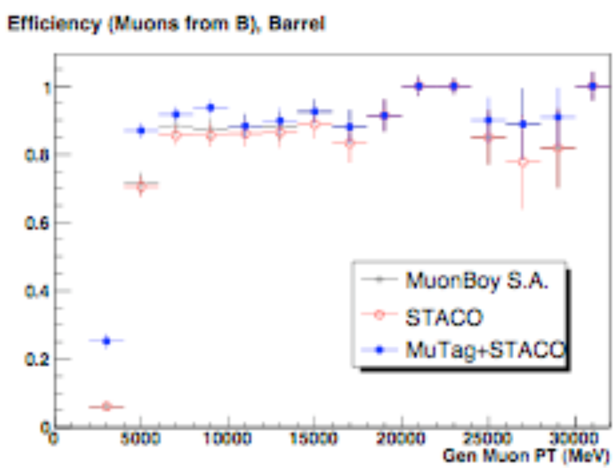
    ← **most powerful tagger**

  - "2nd stream" taggers : (*JetTag)→weightForTag("lhSig")
    corresponding to Lifetime1D+Lifetime2D(+SecVtxBU)

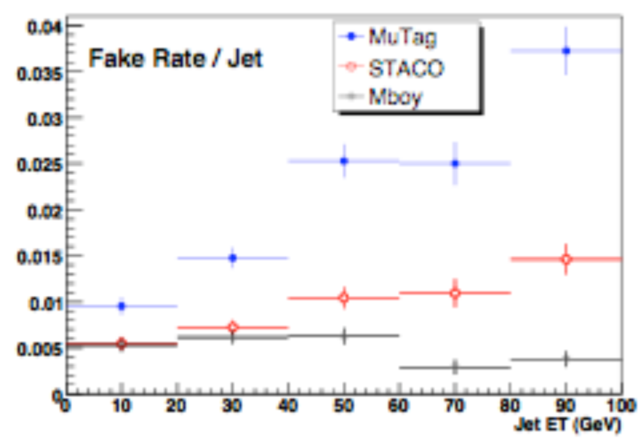
Soft Lepton Taggers:Muon

Soft Muon Tagger

- Implementation in the JetTagging package finished (SoftMuonTag).
- Selection:
  - STACO or MuTag muon
  - $\Delta R < \Delta R^{cut}$ (default: 0.6). Jet momentum corrected for the presence of the muon (i.e. muon momentum added to jet momentum).
  - $p_T > p_T^{cut}$ (default: 4 GeV)
  - $|d_0| < d_0^{cut}$ (default: 4 mm) 2D impact parameter w.r.t. primary vertex.



$p > 3\text{GeV}$

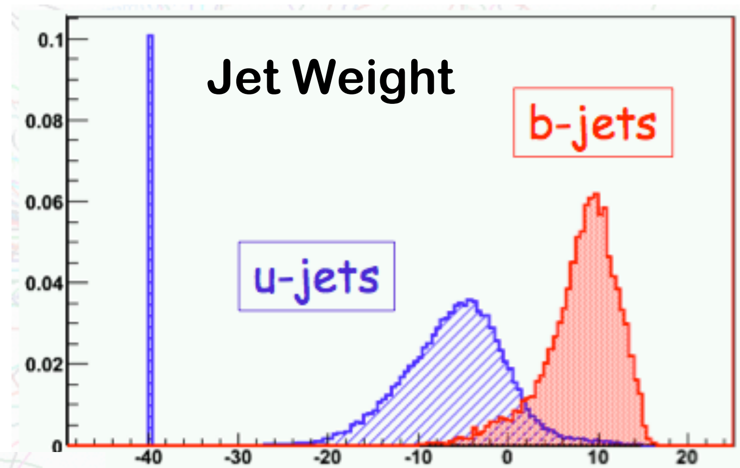


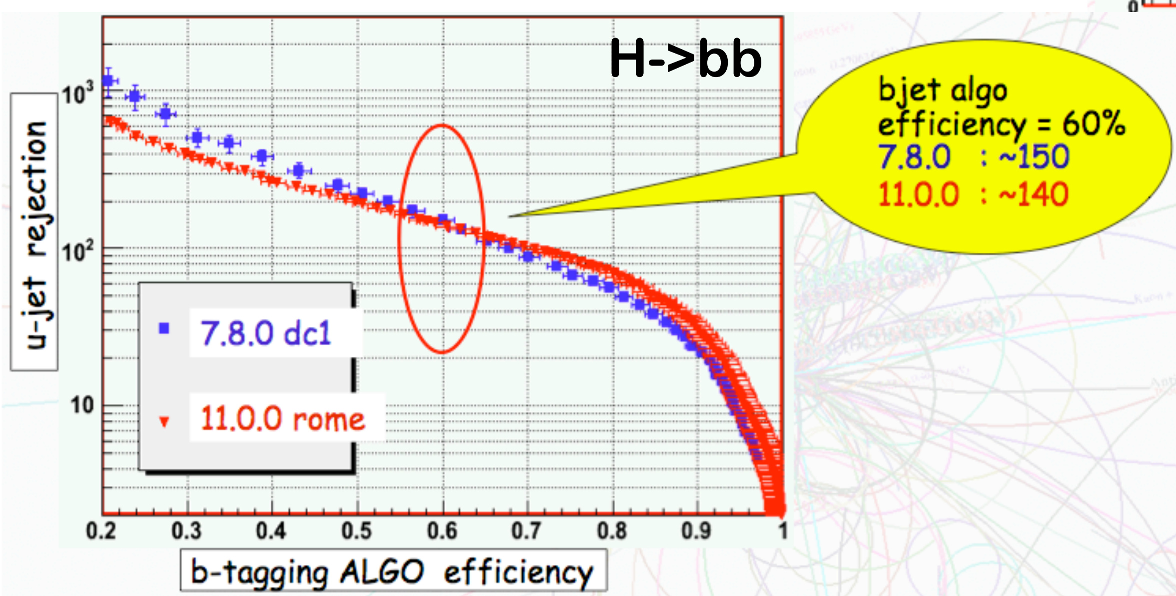
Soft Lepton Taggers:Electron

Soft Electron Tagger

Basic soft electron btagging tools implemented
- ECAL +TRT (+Si)

For each track in the jet:
- soft electron weight from ElectronCollection
- max electron weight stored in SoftLeptonInfo





First Data and b-tagging Commissioning

Ongoing Activities

- Calibration Issues - see previous talk
- Tools for Validation
- Commissioning btag with top data

Tools for Validation

Standard Set of Tools to compare the performances from various algorithms

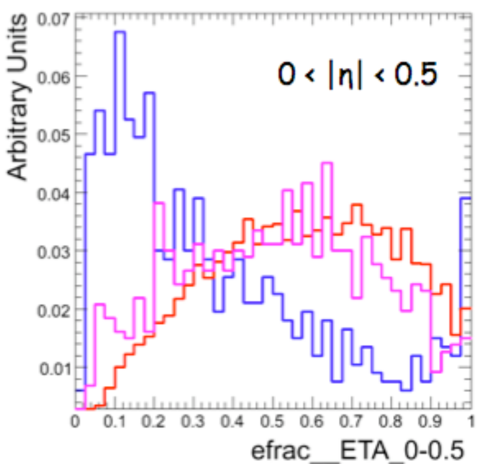
A set of standalone (ROOT only) classes to produce

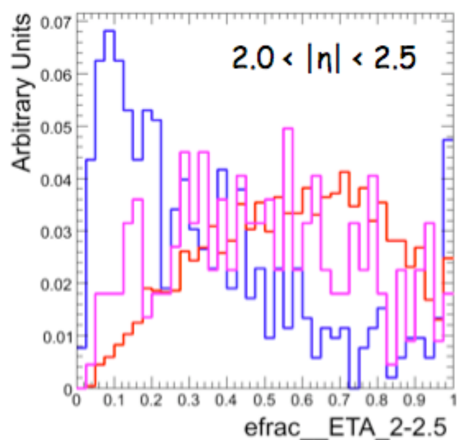
1) Histo and plots of various variables
2) 2D Histos/plots rejection vs b-efficiency
3) mis-identification for a fixed b-efficiency

Freiburg University

Histograms can be used to create pdf (likelihood ratio)

The Root tree can be used to train a NN for combination





Work in progress to integrate with current releases (now based on 10.0.4)

Lifetime Efficiency from top data

It is necessary to evaluate the taggers performance from data

H. Bachacou, May 2006

At the Tevatron this wa done in two ways:
- rejection from jet samples (previous talk)
- b-tag efficiency from semileptonic decay and cross calibration with soft lepton/lifetime taggers

At LHC the high statistics ttbar sample can be used
- relatively pure b-jet sample
- inclusive b-decay (not semileptonic only)
- high E_T sample
- large heavy flavor content:
  - -2 b-jets/events
  - -1 c-jet/2 events from W->jj
- it assumes Br(top->Wb) = 100%

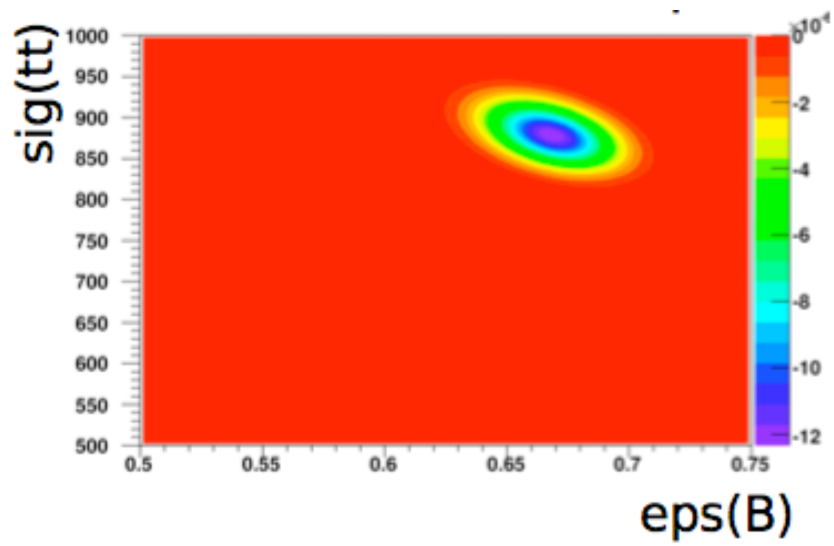
Method: count the number of events with 1,2,3 tagged jets and extract ε(b),ε(c),σ(tt) using a likelihood fit

Lifetime Efficiency from top data

H. Bachacou, May 2006

Several pseudo-experiments (~15 pb^{-1} each)

	'True'	Measured
ϵ_B (%)	67.9±0.2	66.8±2.3
ϵ_C (%)	20.3±0.4	28.5±5.3
ϵ_L (%)	0.93±0.03	-
$\sigma_{t\bar{t}}$ (pb)	857	878±28



Working on systematics and improving event selection
Background evaluation needs more refinement (W+jets ok, QCD?)
- topological likelihood discriminant ?

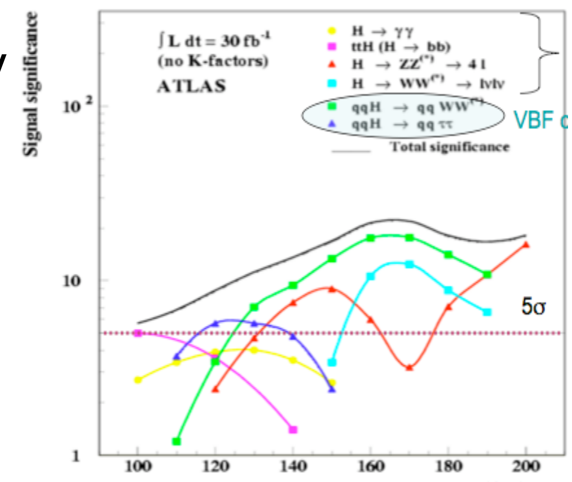
Dilepton channel can be also used (no c-jet component)

B-tagging commissioning

- Already lots of activities ongoing
  - Many more will start and many more will be repeated when first data will be available
    - It's important to have the machinery ready
  - Many variables to test….
    - Detector commissioning (for example effects of misalignment)
    - Simulation issues
      - Tracking, material….
  - not for the first time…
    - TeVatron experience!
  - Much more data than at the TeVatron
    - Top sample:
      - « pure » b sample: ttbar semi-leptonic (and dilepton)
  - « pure » light quark sample (very high purity needed): W/Z+jet ? di-jets ?
  - « pure » c sample: ?

B-tagging and first physics results

- Top
  - will be used for commissioning
    - b-tag will be an ingredient
    - known physics process, useful for testing performance
- Searches
  - “easy” searches don’t need b-tagging immediately
    - Z’,LQ,ED, mass bumps…
    - Third generation searches needs it…
      - cross check with Top



- Higgs
  - Benchmark for performance of the Atlas detector
    - Energy resolution,Etmiss,lepton/photon ID
  - Several of the prominent channels do not make use of b-tagging
    - 4 leptons, $\gamma\gamma$
    - ttH does

Conclusions

- Many performance tests ongoing
  - Driven by physics studies
    - From DC1 to CSC
  - Driven by performance tests
    - Tracking
    - Releases
- Work starting up on b-tagging calibration and performance validation with first data
  - Top sample

Backup Slides

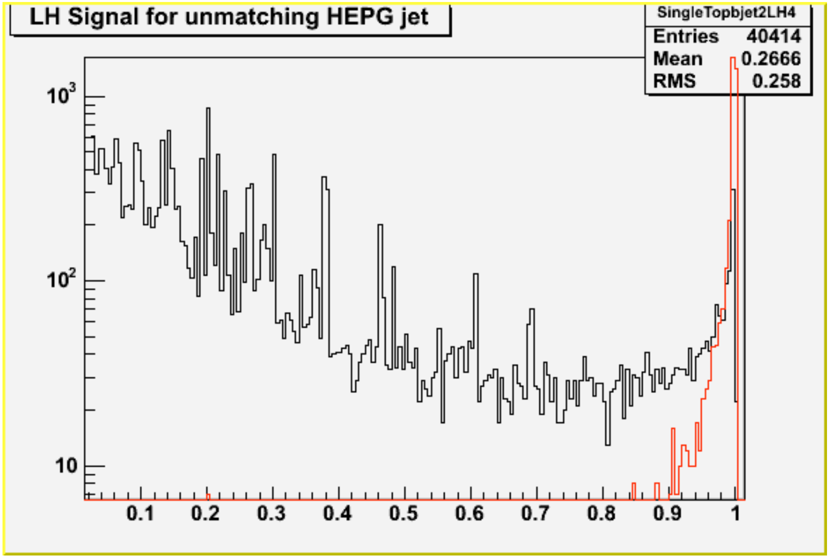
Labelling and purification

- Labelling:
  - To quote performances we need to know the « true » flavour of the jet: not completely trivial…
  - Method used here: label a jet as a b-jet if there is a b-quark (after FSR*) within $\Delta R<0.3$. If not look for a c-quark → c-jet. Otherwise jet is labelled as a light jet.
- Overlapping jets and purification:
  - Overlaps in jetty events → mislabelling
  - Jet isolation very dependent on the type of events and physics processes (gluon jets) + jet algorithm
  - Purification may be used to factorize this from pure b-tagging issues: do not consider lights jets where there is a b/c/quark/hadron within $\Delta R<0.8$

B-tag efficiencies

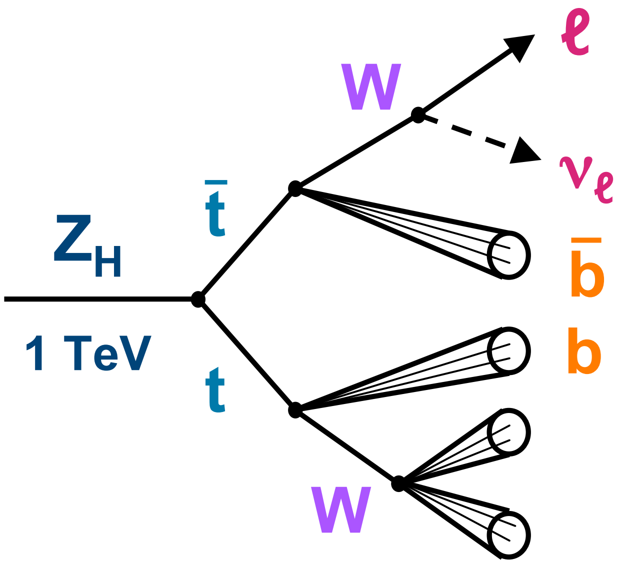
Cross check of LHSig distribution using a different tagger as selector.

LHSig distribution:
IP2D > 3.0 (red)
IP2D < 1.0 (black)



High PT B-jets (in LH models)

ATL-PHYS-PUB-2006-003

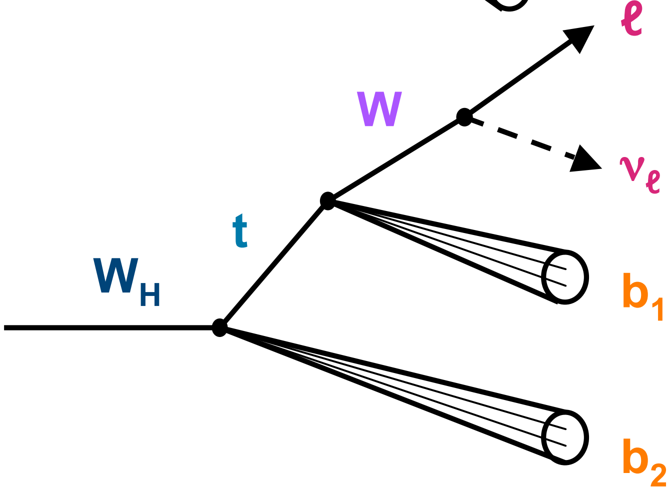


p_T (b-jets) ~ 250 GeV

Z_H (2 Tev) $\rightarrow$

b b	20000 events
u u	20000 events
c c	20000 events

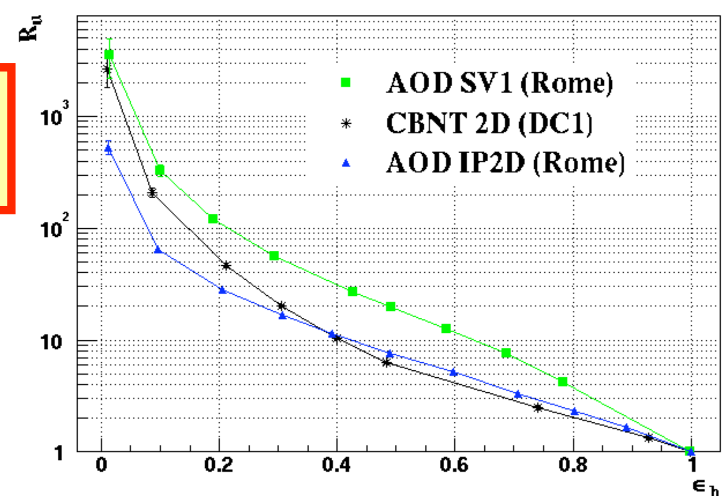
ATHENA release <u>10.0.1</u> - Full Simulation



Room for further development

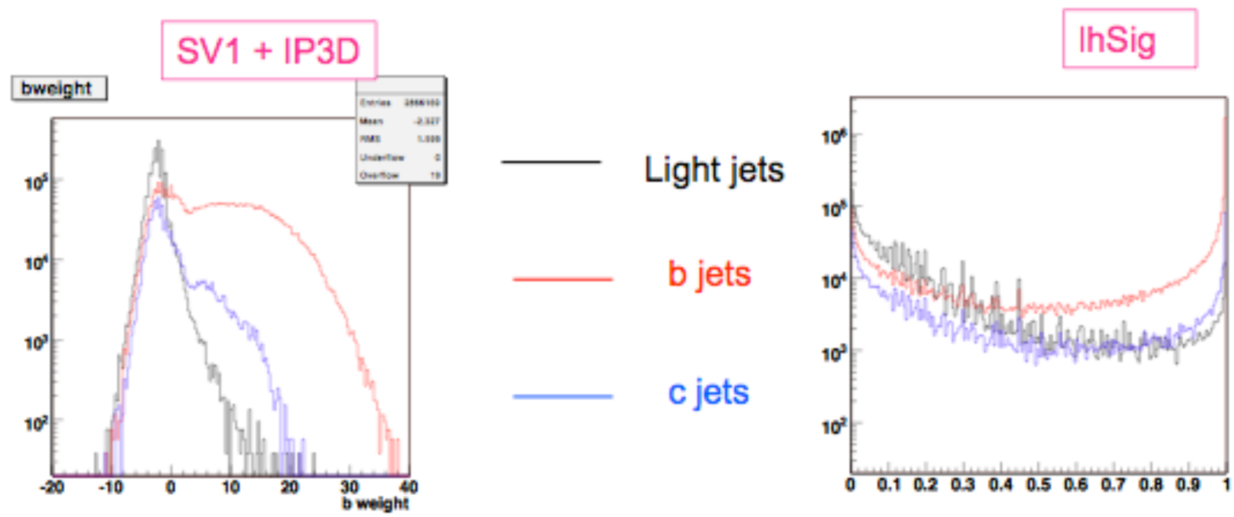
p_T (b_1) ~ 250 GeV

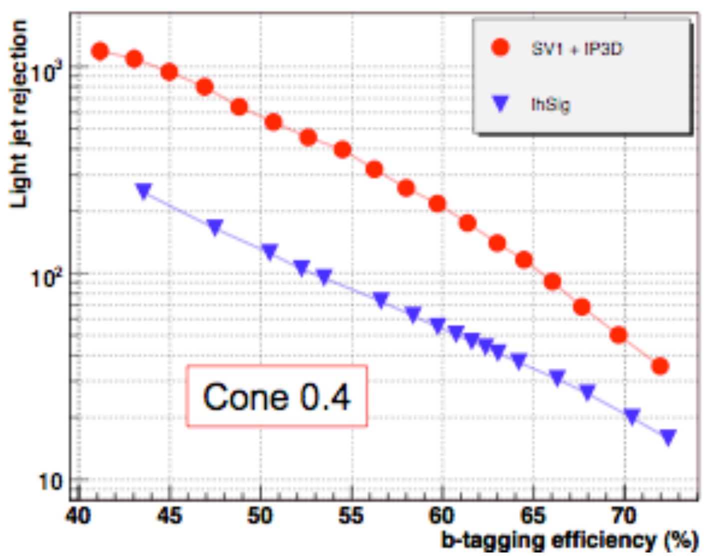
p_T (b_2) ~ 500 GeV



b-tagging in ttbar events: 10.0.1

Rome sample 4100,
semileptonic ttbar events
Reconstruction 10.0.1
b-tag rerun with patches





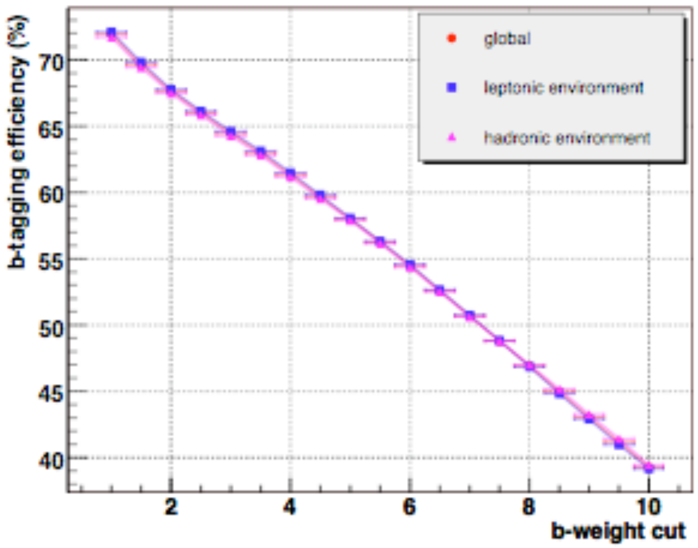
	R_l (ε = 50 %)	R_l (ε = 60 %)
SV1 + IP3D	593 ± 8	207 ± 3
lhSig	132 ± 4	53 ± 2

A.I. Etienvre, Dec 2005

b-tagging in ttbar events: 10.0.1

Environment

Comparison of the b-tagging efficiency in the two sides (leptonic/hadronic)



→ Nearly identical !

For a b-weight cut = 3:

	Global	Leptonic environment	Hadronic environment
Efficiency (%)	64.5 ± 0.1	64.6 ± 0.1	64.3 ± 0.1

A.I. Etienvre, Dec 2005

b-tagging in Top Physics

- In ttbar events, b-tagging of a jet is defined as SV1 + IP3D ≥ 3
  (SV2 + IP3D when available)

- b-tagging performances obtained with this cut on cone 0.4 size jets:

→ Light jet rejection = 116 ± 4
→ b-tagging efficiency = 64.5 ± 0.1 %
→ c jet rejection = 6.1 ± 0.1

- b-purity in top mass measurement:

63.2 ± 0.9 %

- For top mass measurement, these performances are perfect, but any advice in order to optimize the b-tagging performances is welcome!

A.I. Etienvre, Dec 2005

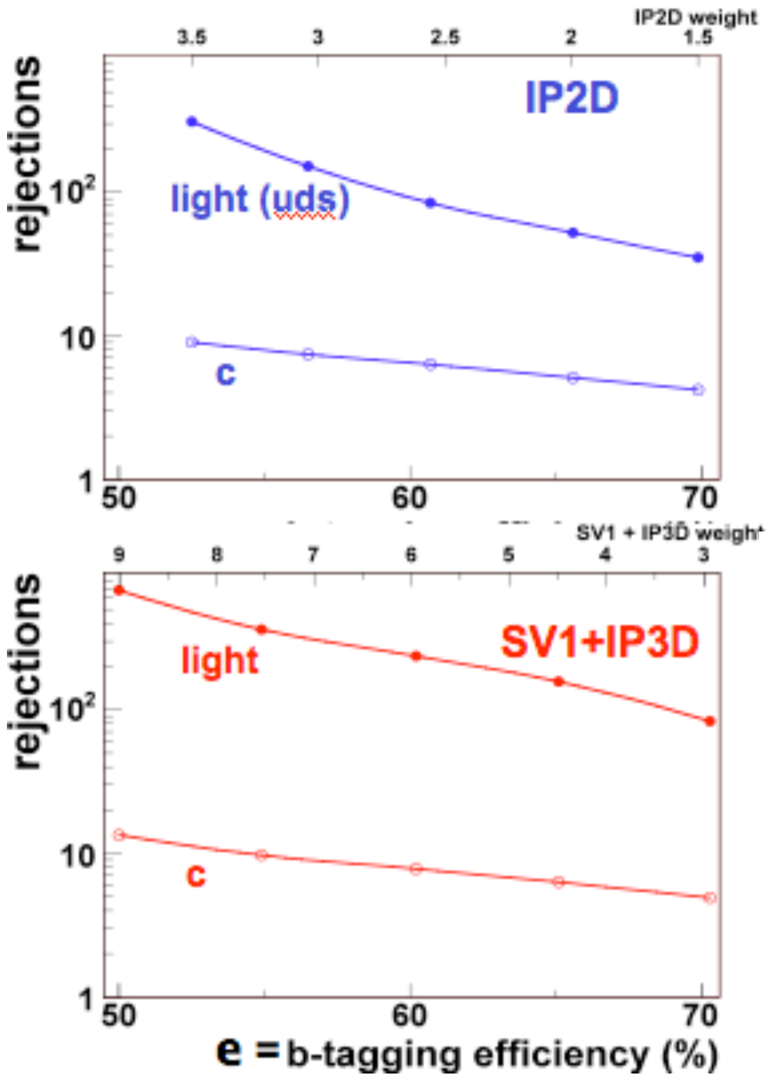
ttH vs ttjj : 10.0.1

- The most complicated (interesting!) of the benchmarks
  - busy events with overlaps, mislabelling issues
- b-jets: ttH Pythia (samples 4867, 4868) 20k evts
- u-jets: tt(jj) MC@NLO
  - tt (sample 4100 T1) 243k evts
  - tt(jj) (samples 4870,4871) 259k evts
    - Filter to select high jet multiplicity (j6pT14)
    - ϵ = 44%
- From AODs, cone ΔR=0.4, iPatrec tracks, Release 10.0.1 + patches
- Statistics: 75k b-jets, 1.2M u-jets (Caveat: not the same generator)

L. Vacavant, Mar 2006

	R_u (ϵ_b=50%)	R_u (ϵ_b=60%)	R_u (ϵ_b=70%)
IP2D	**218 ± 3**	**66 ± 1**	**23**
SV1+IP3D	**882 ± 24**	**297 ± 5**	**59**

b-tagging in ttbar events: 11.0.41



MC@NLO+HERWIG (10000 evts)

	e=50%	e=60%
R_c	10 / 13	6 / 8
R_{uds}	500 / 680	90 / 230

- ➔ Results improved compared to Rome by 20% for R_c and 50% for R_{uds} at e=60%
- ➔ Need to check with the background when simulated.

P. Pralavorio, , March 2006

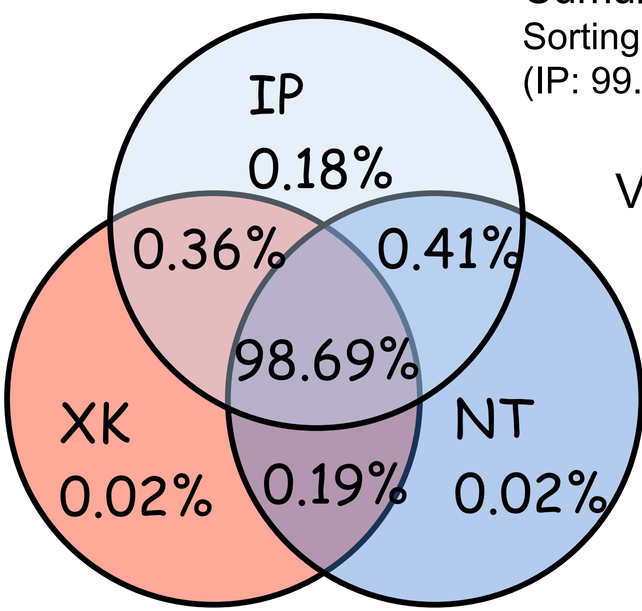
Digression on Tracking eff (11.5.0)

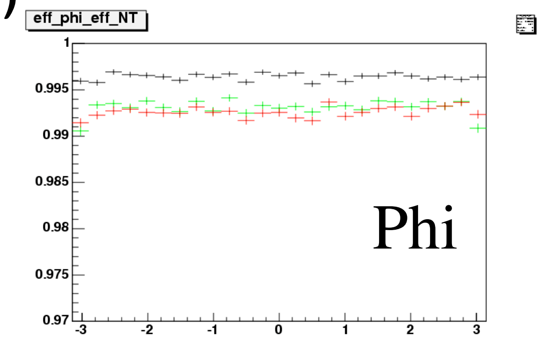
Integrated Tracking eff and fake rates (basic selection)

	11.0.41 Eff (%)	11.0.41 Fake (%)	11.5.0 Eff (%)	11.5.0 Fake (%)
IP	97.3	4.02	99.6	0.47
XK	97.7	2.08	99.3	0.54
NT	95.7	5.46	99.3	0.34

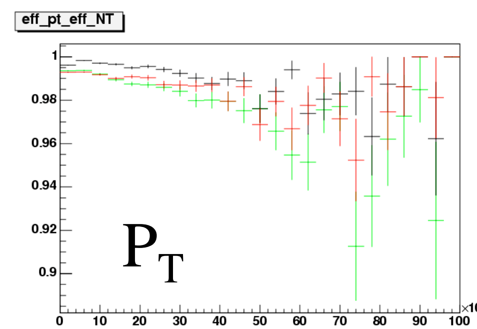
Cumulative Efficiency: 99.87%
Sorting tracks and removing duplicates
(IP: 99.6%, XK/NT: 99.3%)

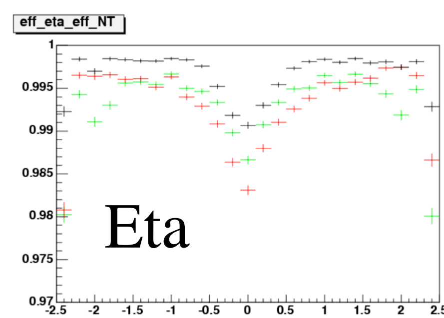
Venn Diagram for overlap





IP
XK
NT





Tracking Eff comparisons

CSC tt sample 5200, simu 11.0.4, reco 11.5.0, VxPrimary, no shared hits, no cleaning , small stat. 10K (updated 31.05.06)

Track finding	xKalman	xKalman	iPatrec	iPatrec	newTrack	newTrack
Calibration	Old xKalman	Old iPatrec	Old iPatrec	Old xKalman	Old newTrack	Old iPatrec
2D 60%	70 ± 4	70± 4	75 ± 4	71 ± 4	70 ± 4	92 ± 6
3D 60%	108 ± 7	104 ± 7	130 ± 10	137 ± 10	108 ± 7	154 ± 13
3DSV1 60%	189 ± 17	195 ± 18	319 ± 37	316 ± 37	218 ± 21	265± 28

Better numbers with cleaning

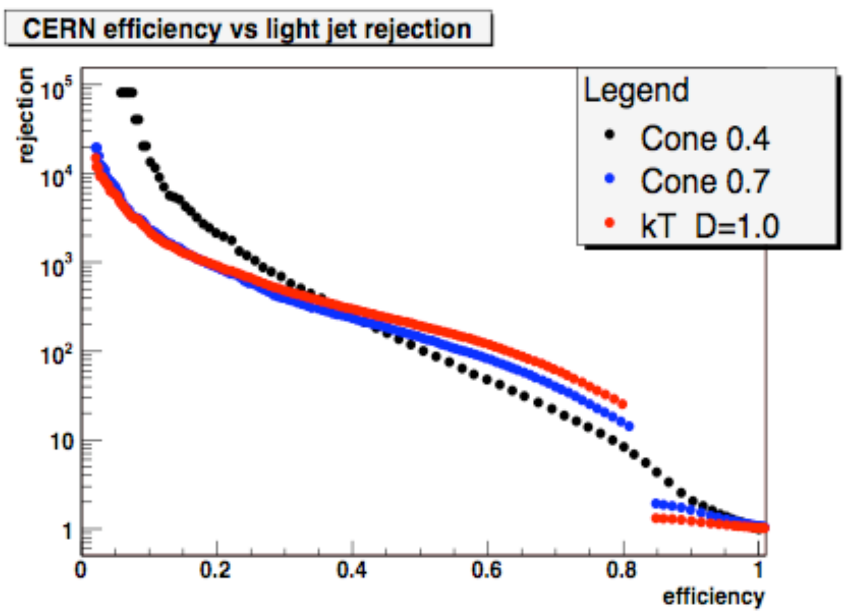
A. Rozanov, , June 2006

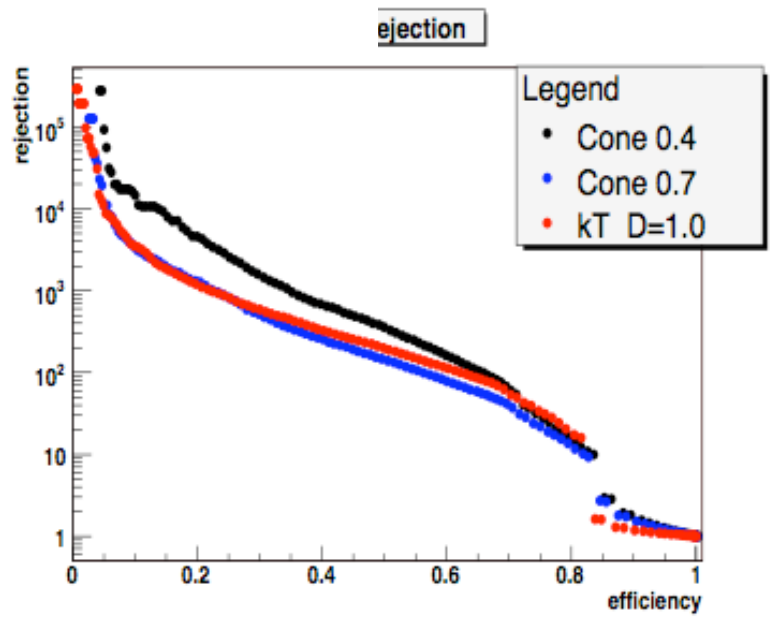
b-tagging and Jet algorithms

"jump" at efficiency of ~ 0.8 from peak of weights for light jets

Cone 0.7 and kT have similar behaviour

80k ttbar events, DC3, 11.0.41





Marisa Sandhoff

Wt: Efficiencies (P_T and η)

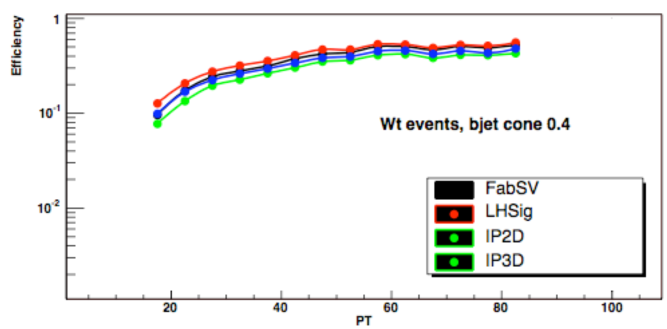
Efficiencies are calculated in the following way:

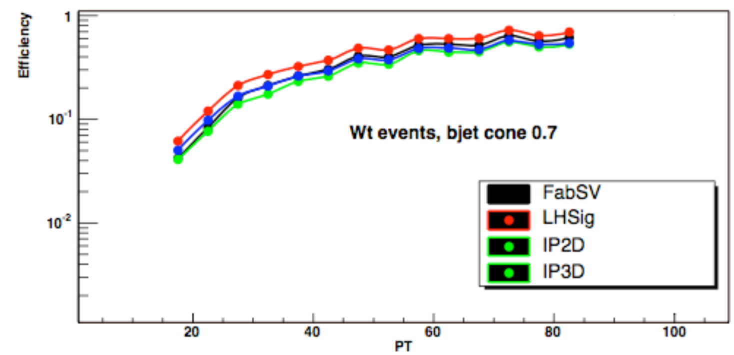
Denominator: number of b-partons with P_T and η in given interval;

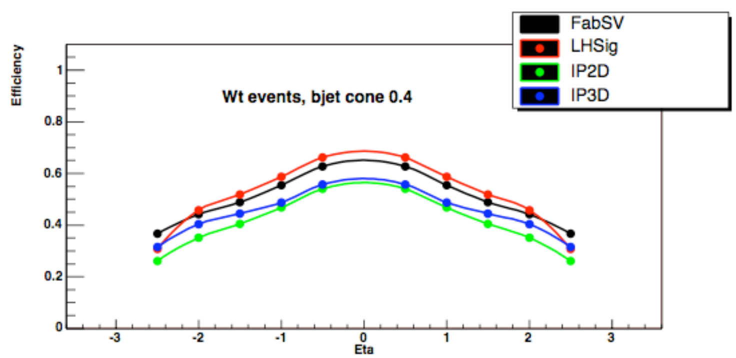
Numerator: bjets matched with the b-parton (parton level info) with P_T and η in given interval and cut on weight/LHSig.

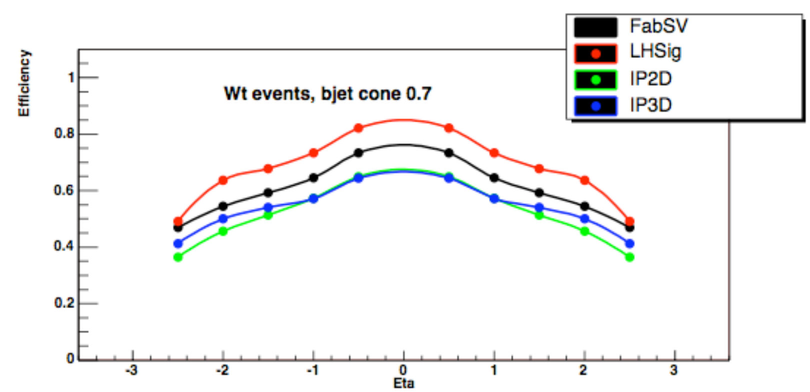
weight/likelihood cut fixed

S. Rolli, June 2006









b-tagging in Single Top

- <u>B-Tag studies on Wt, W-g, W* AOD samples</u>:
  - Preliminary tests on various b-tag algorithms, as out of the box on Rome samples for single top were performed
  - Reprocessing of data to obtain cone 0.4 bjets was done;
  - Generally good agreement with other samples studies
  - LHSig has slightly higher efficiency to select b-jets (LHSig > 0.9) in the data but has a very poor rejection factor.
  - SV1 has slightly lower efficiency, but much higher rejection factor.

S. Rolli, March 2006

Wt	R_u (ε_b = 50%)	R_u (ε_b = 60%)
IP2D	166 (125) (158 -109)	25 (50) (55-57)
LHSig	NA (172-NA)	33 (33) (66-NA)
SV1 + IP2D	333 (100) (505-325)	100 (33) (184-156)

Impact of (mis)alignment

Use CDF experience:

S. Gibson, Oxford

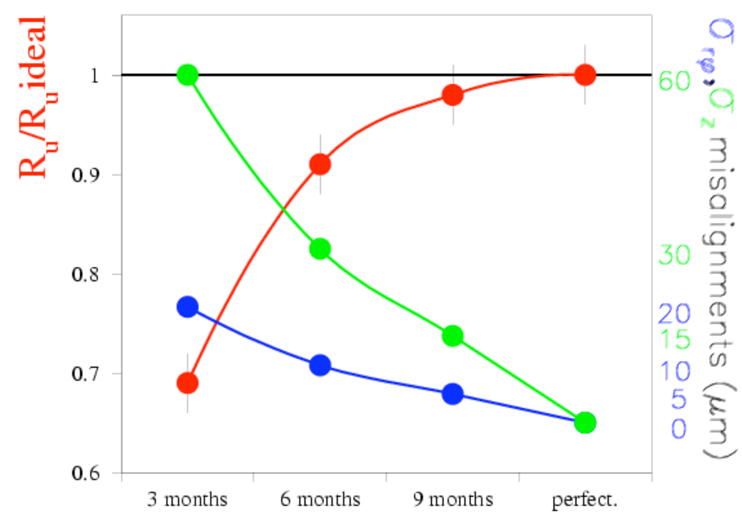
Map CDF commissioning misalignments from CDF run II to ATLAS and propagate to b-tagging performances (via degradation in track momentum, d0 resolutions)

		2D algorithm		*3D algorithm*	
		Perfect	Misaligned	Perfect	Misaligned
$R_u(\epsilon_b)$	$\epsilon_b = 50\%$	155 ± 8	138 ± 6	348 ± 22	316 ± 19
	$\epsilon_b = 60\%$	47.1 ± 1.1	43.6 ± 1.0	89.0 ± 3.4	81.7 ± 2.7
$\frac{R_u^{\text{Misaligned}}}{R_u^{\text{Perfect}}}$	$\epsilon_b = 50\%$	0.89		0.91	
	$\epsilon_b = 60\%$	0.92		0.92	

➔~10% degradation
➔Equivalent to 10 μm rφ misalignment

Random misalignments:
IP3D tagger , ttH events, realistic conditions
(redo exercise with detector misaligned from simu)

improving alignment up to almost perfect in one year,
➔recovery of light jet rejection



Lifetime Efficiency from top data

H. Bachacou, May 2006

Working hypotheses:

- Br(top->Wb) = 100%
- ε(b),ε(c), ε(light) assumed independent of number of tags

Inputs:

- backgrounds need to be evaluated for each sub-sample
- ε(light) needs to be measured somewhere else (for now simulation, ε(light) = 0.01)
- σ(tt) measurement ingredients: trigger eff, ID eff, acceptance etc…

- $L = Poisson(N_1, < N_1 >) \cdot Poisson(N_2, < N_2 >) \cdot Poisson(N_3, < N_3 >)$
- N_n = Number of observed events with n tags
- $< N_n >$ = Expected number of events with n tags : function of ϵ_B, ϵ_C, ϵ_L, $\sigma_{t\bar{t}}$, etc...

$$< N_n > = (L \cdot \sigma_{t\bar{t}} \cdot A_{pre-tag}) \cdot \Sigma_{i,j,k} \boxed{F_{i,j,k}} \Sigma_{combi.} A_i^{i'} \cdot \epsilon_b^{i'} \cdot (1-\epsilon_b)^{i-i'} \cdot \epsilon_c^{j'} \cdot (1-\epsilon_c)^{j-j'} \cdot \epsilon_l^{k'} \cdot (1-\epsilon_l)^{k-k'}$$

$i = \#$ b-jets and $i' = \#$ tagged b-jets

$j = \#$ c-jets and $j' = \#$ tagged c-jets

$k = \#$ l-jets and $k' = \#$ tagged l-jets

$\boxed{F_{i,j,k} = \text{Fraction of events with } i \text{ b-jets, } j \text{ c-jets, } k \text{ l-jets.}}$

$A_i^{i'} = i!/(i'! \cdot (i-i')!)$

$\sigma_{t\bar{t}}$ = production cross-section

$A_{pre-tag}$ = acceptance without b-tagging

L = integrated luminosity